

Biosecurity Compliance and Its Applications in Poultry Production Sectors

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Received: June 21, 2024, Revised: July 23, 2024, Accepted: August 19, 2024, Published: September 25, 2024

ABSTRACT

Poultry farming has been recognized as one of the most vital sectors for the economy and revenue generation in many countries. For the production of high-quality freshly hatched chicks, effective cleaning and sanitation of the hatchery environment and hatching eggs were crucial components of proper management and hygiene in chicken hatcheries. The current review aimed to assess the efficient ways of mitigating the risk of disease introduction (external biosecurity) and its subsequent dissemination (internal biosecurity) within and between poultry farms and hatcheries. In addition to identifying the variety of risk categories that are applied to various biosecurity industries, this article clarified the equivalent tools, including checklists and/or questionnaires, that can be used to assess biosecurity compliance. The checklist was aimed to evaluate numerous biosecurity protocol categories, including the farm's infrastructure, employees, their education and training, access control mechanisms, cleaning and disinfection procedures, handling of litter and waste, chick control, registrations, and pest management. In conclusion, external biosecurity was critical to preventing infections from entering hatcheries and poultry farms. Questionnaires or checklists were effective instruments for gathering information on biosecurity and evaluating compliance in poultry farms.

Keywords: Biosecurity compliance, Checklist, Hazard, Poultry sector

INTRODUCTION

Poultry sectors are under threats from numerous kinds of viruses, bacteria, and other microorganisms. To lower mortality and morbidity, several immunization programs have been developed for parent stock, broiler, and layer chickens. However, in an effort to lessen the possibility of bacterial and viral shedding further becoming an issue on the farm and/or on the farm's neighboring, new biosecurity measures have been implemented. Effective use of disinfectants and sanitizers is essential to any biosecurity strategy (Abdelaty et al., 2019).

In poultry farms, biosecurity refers to the health protocols and measures designed to protect a population from transmissible infectious agents. It is the initial line of defense against diseases that could affect food safety, the well-being of animals, and the farm's economic viability. The most commonly practiced biosecurity measures

include farm sanitation, infrastructure maintenance, proper cleansing, and efficient disinfection equipment and procedures (Tilli et al., 2022).

The danger of infectious disease transmission in traditional poultry farming poses a significant risk to the health and welfare of the chicks due to factors, such as excessive stocking density, low genetic variation, inadequate ventilation, and immunosuppression (Espinosa et al., 2020). Biosecurity is one of the most effective strategies to remove the risk of disease introduction between farms and subsequent internal and external dispersion (Van Limbergen et al., 2018). Thus, the proper implementation of interior (e.g., cleaning and disinfection, segregation of poultry facilities, and home hygiene lock) and exterior (e.g., feed supply, admission of visitors and vehicles, and farm location) biosecurity should be given top priority (Damiaans et al., 2020).

The presence of biofilms in the environment of chickens is considered a significant challenge, which has the potential to make any biosecurity program fail. Thus, before disinfecting the poultry house, a step for biofilm removal needs to be introduced (Abdelaty et al., 2019). The disinfection and cleaning program should be carried out as economically and safely as possible, which entails minimizing the frequency of doing so in the shortest possible time, with the least amount of capital spent on labor, chemicals, and energy, creating the least amount of waste, and causing no damage to the machinery. Routines for cleaning and disinfection must be carried out with expertise and experience. The polysaccharide matrix of biofilms acts as a barrier to shield connected cells from disinfectants, making it harder to remove the attached bacteria and biofilm. Additionally, attached cells exhibit greater resistance to biocides compared to planktonic cells. Therefore, it is crucial to take into account the special characteristics of biofilms when developing cleaning techniques (Costerton et al., 1995).

Maintaining high sanitation efficiency through proper cleaning and sanitary maintenance is crucial for both avian production and the reduction of infectious disease spread (Lazarov et al., 2018) using disinfectants such as quaternary ammonium compounds, glutaraldehyde, chlorine, peroxides, phenolic, and formaldehyde at bactericidal concentrations (Narayan et al., 2023). The current study aimed to evaluate efficient tools for mitigating the threat of disease introduction and subsequent dissemination between hatcheries and poultry farms. Additionally, it sought to identify the various categories of hazards applicable to various biosecurity sectors and clarify comparable tools such as checklists and/or questionnaires to assess biosecurity compliance.

The concept of biosecurity

When referring to safeguarding, the term "biosecurity" was primarily utilized for controlling biological weapons. The key goal of biosecurity was to safeguard against the hazards that pathogens and living things pose. Elimination, extermination, and control were the main tools of biosecurity, supported by effective system management, useful policies, and the efficient sharing and safeguarding of critical data, as illustrated in Figure 1. Bakanidze et al. (2010) noted that "when working with potentially contagious microbes and other biological dangers, implementation of laboratory techniques and practices, particular elements of laboratory construction, protective clothing, and

appropriate health and safety program" is what is meant by biosafety, which is a supplement to biosecurity.

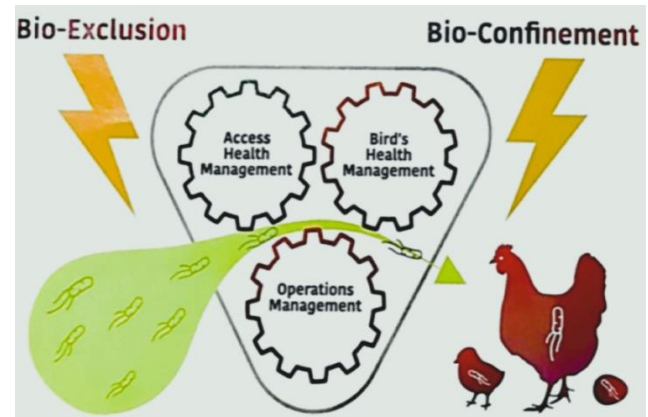


Figure 1. The main goals of biosecurity measures applied in poultry farms

Many countries have embraced the idea of biosecurity, incorporating it into several sector-specific strategic documents. In the context of animal health and production, biosecurity is defined as "a collection of physical and managerial precautions intended to minimize the possibility of animal infections and diseases entering, and spreading within an animal population" (OIE-FAO, 2009). Consequently, there are conflicting interpretations of biosecurity despite efforts to develop a single definition that encompasses "the approaches for evaluating and controlling the risk of diseases that are transmissible, quarantine pests, living altered organisms, and biologic weapons" (Meyerson and Reaser, 2002).

According to OIE-FAO (2009), biosecurity refers to all efforts taken to stop pathogen introduction (bio-exclusion) and to limit their spread (bio-containment). Biosecurity is integral to the concept of health, as it involves inhibiting transmission to humans, pets, plants, and surrounding environments. The definition provided by the WHO and FAO, which takes these factors into account, is appropriate and should be used as a reference point by other stakeholders to highlight the significance of biosecurity for public health, environmental protection, and animal health.

Biosecurity addresses various hazards across several industries, including food safety and human health, pets, and plants. Particular emphasis is placed on biological weapons, invasive alien species, and zoonoses. Thus, the classification of risks and hazards that need to be addressed varies depending on the sector, as shown in Table 1.

Table 1. Different categories of hazards applicable to different biosecurity sectors

Biosecurity Sector	Kinds of hazards
Animal health	Any pathogen that could have a negative impact on an animal's health
Zoonoses	A biological agent that may spread from domestic or wild animals to human beings.
Food safety	A physical, biological, or chemical substance included in food or its present form could have a negative impact on health.
Plant health	Any plant, animal, or pathogenic agent species, strain, or biotype that harms plants or botanical products.
“Biosafety” in relation to plants and animals	A living modified organism (LMO) with a unique genetic profile created by recent biotechnology that could have negative consequences for the preservation and sustainable use of biological diversity while also posing health risks to humans.
“Biosafety” in relation to food	A recurrent DNA organism that exists in food and has the potential impact on human health.

FAO Biosecurity Toolkit. Source: [FAO \(2007\)](#).

Biosecurity compliance of poultry farms

Questionnaires and similar tools, such as checklists, are frequently used to evaluate biosecurity compliance. These tools involve the assessor responding to several inquiries on the biosecurity measures that have been implemented ([Renault et al., 2018](#); [Damiaans et al., 2020](#)). Depending on the surveys and the national legislation in existence, the ultimate assessment of both internal and external biosecurity can be either quantitative ([Tanquilut et al., 2020](#)) or qualitative ([Sahlström et al., 2014](#)). In case of unfavorable results, several alternatives can be used, including the provision of recommendations, imposing fines, or offering training for staff and farmers ([Caekebeke et al., 2021](#)). Questionnaires or checklists are effective instruments for collecting information on biosecurity, all-in/all-out production systems in poultry farms and evaluating the compliance of poultry farms both within and outside of the European Union ([Van Limbergen et al. 2018](#); [Correia-Gomes and Sparks, 2020](#); [Ornelas-Eusebio et al., 2020](#)). The implementation of biosecurity protocols in chicken farms is governed by national regulations that mandate frequent inspections by official veterinary services. These inspections evaluate compliance with biosecurity standards through the use of nationally standardized checklists ([European Commission, 2022](#)). Given that infectious diseases have the potential to seriously disrupt the entire supply chain, biosecurity precautions must be put in place during recurrent avian influenza (AI) epidemics ([Mulatti et al., 2017](#); [EFSA, 2021](#)).

It is crucial to have external biosecurity to prevent infections from getting into poultry farms. Studies have shown that compared to internal biosecurity, external

biosecurity is marginally more compliant. The most commonly adhered-to measures include the cleaning of "filter zones", which are similar to farm hygienic locks comprising sanitary and cleaning zones, having clean basins and equipment for cleaning (i.e., liquid or bars of soap, disposable or sanitary towels or dryers for hands and clothes storage areas), and footwear cleaning facilities ([Chowdhury et al., 2012](#)). Other biosecurity-related variables include access control (e.g., gate/bar closed upon arrival), vehicle disinfection (e.g., spray bay), and animal control. Still other biosecurity-related variables include internal biosecurity variables, such as walls, roofs, washable and disinfectable floors, and intact walls in house premises. All these variables have demonstrated high biosecurity compliance, marking a significant advancement in the application of biosecurity measures. Maintaining intact walls limits the existence of invertebrates, which may otherwise hide in crevices and act as transporters for poultry infections. Suitable cleansing and disinfection techniques are also essential for limiting the transmission of pathogens ([Souillard et al., 2014](#)).

Biosecurity Checklists

Some questions are broken up into further sections on the checklists for poultry farms. The objective of every section is to assess various categories of biosecurity protocol, involving the farm's infrastructural features, the number of employees, their education and training, the access control systems, the cleansing and disinfection protocols, the management of litter and manure, the bird control, the registrations, and the pest control. Additionally, the layer checklist includes sections on egg

care. A handful of the questions are open-ended, but the majority need a "yes" or "no" response. During in-person interviews, the official veterinarian has asked the farmer certain questions specific to him or her and, therefore, has depended on his or her credibility. When there are no biosecurity-related non-compliances displayed by the inspected farm, the outcome is deemed positive. In case the result is unfavorable, recommendations or fines are imposed, and corrective actions are documented in the checklist, as shown in Table 2, based on [Tilli et al. \(2022\)](#).

Hierarchy of biosecurity levels

To restrict the entry or limit the transmission of pathogenic agents that cause infectious diseases, a biosecurity program combines physical barriers like fences and mesh wire with targeted actions like footbath use, carwash deep cleansing, and equipment disinfection in the farm ([Aiyedun et al., 2018](#)). According to [Kouam et al., \(2018\)](#), traffic control, segregation, and sanitation are the three components of biosecurity measures. [Van Limbergen et al. \(2017\)](#) and [Sasaki et al. \(2019\)](#) further categorize biosecurity into two types: Internal and external. Biosecurity can be structured into three levels: Conceptual, structural, and operational ([Maduka et al., 2016](#)).

Farm locations fall under the conceptual category. Structural considerations include building layouts and amenities that ward off intruding wildlife and raptors. Operational considerations include the regular cleaning, sanitation, and work practices that farm workers and guests adhere to [Shane \(1997\)](#). The farms' biosecurity protocols have an impact on the birds' performance ([Wijesinghe et al., 2017](#)). The conceptual biosecurity includes elements like the separation between homes and farms, the distance from the main road, the existence of standing water, the type of house, the location of the house, and the construction materials used in the house. The presence of a farm gate and fence, footbaths, tire baths or sprays, restrictions on vehicle entry, visitor sign-on logbooks, and bans on purchasing day-old chickens, and feed. Among the issues raised by the structural framework are a truck sharing space with other farms, continuous rodent control, and a limitation on accessing newly stored litter intended for wild bird control ([Ismael et al., 2021](#)). In conclusion, the questions focus on using certain clothing, shoes, masks, and hats, routine washing and disinfection, using high-pressure sprayers, appropriate handling of deceased chickens, absence of other animals on the property, veterinarian advice, intervals between

disinfection cycles, preventive care, and immunization, as shown in Table 3.

Table 2. Biosecurity checklist for poultry farms distributed to various sections.

Checklist section	Category
1. The farm's infrastructural features	
1.1 Year of building.	Year
1.2 Surface area of the farm.	m ²
1. Number of brick sheds.	Numbers
1.4 Gender of reared broilers (Male, Female, mixed sexes)	Select Gender
1.5 Farm entrance boundary (presence of gate)	Yes/No
1.6 If the gate/bar is closed on arrival	Yes/No
1.7 Presence of ≥ 1 area for storage materials (e.g. farm equipment, materials, fresh litter, etc.).	Yes/No
2. Boundary of the farm area	
2.1 Presence of other buildings not belonging to the farm	Yes/No
2.2 Presence of vehicles not dedicated to farm activities inside the farm area.	Yes/No
3. Equipment for vehicle cleaning and disinfection	
3.1 Presence of a spray bay with a waterproof floor.	Yes/No
3.2 The disinfection system is adequate.	Yes/No
3.3 Presence of a permanent automated installation for vehicle disinfection	Yes/No
3.4 Equipment for vehicle cleaning is working.	Present/absent
4. Dead-bird disposal	
4.1 Disposal notes are stored in the farm.	Yes/No
4.2 Carcasses loading is always during the production cycle.	Yes/No
4.3 Presence of a refrigerated storage container	Yes/No
5. Litter and manure management	
5.1 Fresh litter is used in the house without being stored.	Yes/No
5.2 No addition of litter during the production cycle.	Yes/No
5.3 A platform for manure storage is present.	Yes/No
5.4 Built-up litter (manure) is stored.	Yes/No
6. Rodent and pest control	
6.1 Managed by the farmer	Yes/No
6.2 The control procedure is dated and signed	Yes/No
6.3 Pesticides used during the cycle or at the end.	Yes/No

Table 3. The indicator points of conceptual, structural, and operation biosecurity levels in poultry farms.

Indicators of biosecurity level	Category
Conceptual level	
Distance of the farm from the main road (m)	%
Distance from the nearest farm (m)	%
Distance from the residential place (m)	%
No standing water near the farm	Yes/No
Premise with modified open side and curtains	Yes/No
Housing position	East-west/ others
Biosecurity training for employee	Yes/No
Structural level	
The presence of a fence and gate	Yes/No
Presence of footbath dip	Yes/No
Farm vehicle parked off the farm	Yes/No
Visitors sign on logbook	Yes/No
No equipment exchange with other farms	Yes/No
Operational level	
Use of special clothes, footwear, masks, hat, and coveralls	Yes/No
Visitors' special clothes, and footwear,	Yes/No
Regular cleaning and disinfection	Yes/No
Proper disposal of dead chickens	Yes/No
Removed litter stored at a cover shade	Yes/No
No access to stored food for rodents	Yes/No
The presence of an isolation room for diseased chicken	Yes/No
Sick birds are regularly examined	Yes/No
Vaccinating chickens for diseases	Yes/No

CONCLUSION

Biosecurity regulations require ongoing implementation and education of employees, as biosecurity compliance in intensive poultry operations was a crucial step in preventing the entry and dissemination of infectious diseases. While the questionnaires had shown to be an effective method for collecting data, they may only capture the state of biosecurity at the time they were completed, potentially missing ongoing efforts.

Safeguarding poultry flocks against microbial contamination was a critical aspect of the modern chicken production. Poultry growers may face severe economic consequences if a highly virulent and contagious disease organism was introduced into their flocks. The efficacy of a program in biosecurity can be maximized by regional involvement. The program will work better as a whole if all poultry growers use the optimal managerial programs, even though any level or degree of biosecurity is beneficial. As a component of any effectively managed

program, putting good biosecurity practices into daily practice can help minimize the likelihood of becoming affected by pathogenic agents and, in cases of an outbreak, help prevent the progression of the disease.

DECLARATIONS

Funding

This review article did not receive any funding.

Acknowledgments

All gratitude and appreciation to my institution for helping researchers publish academic papers on interesting points.

Authors' contributions

Asmaa N. Mohammed was responsible for data collection, study design, writing the article, and approving the final version of the manuscript for publication in this journal.

Competing interests

The author declares no competing interests.

Ethical considerations

Ethical issues, including plagiarism, consent to publish, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancy, were addressed by the author.

Availability of data and materials

All data and materials are included in this review article.

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